MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2019/2020

EMG4116 – IMAGING RADAR SYSTEMS

(TE)

04 MARCH 2020
9:00 – 11:00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages with 3 Questions only .

2. The student is required to answer all questions in this question paper. Each question carries a particular marks and the distribution of the marks is given .

3. Please write all your answers in the Answer Booklet provided .

Question 1

(a) With aid of a geometry of synthetic aperture radar (SAR) diagram, discuss the basic operation of a SAR system.

[12 marks]

(b) Derive and shown that the Signal to Noise Ratio of SAR can be presented as

$$SNR = \frac{P_t G^2 \lambda^3 \sigma^o PRF}{(4\pi)^3 R^3 N_o 2vL_s}\left(\frac{c}{2B\sin\theta_i}\right)$$

where P_t is the transmitted power, G is the gain of the antenna, λ is the wavelength, σ^o is the back scattering coefficient, PRF is the pulse repetitive frequency, c is the speed of light, R is the distance between radar and target, N_o is the Noise, B is the bandwidth of SAR and θ_i is the look angle.

[14 marks]

(b) What is the meaning of a Chirp Pulse (Linear Frequency Modulation Pulse, LFM Pulse), and why is it used? Sketch a Chirp Pulse signal.

[9 marks]

Continued .....

Question 2

(a) With aid of a flow chart, describe the principal steps of processing Synthetic Aperture Radar raw data.

[10 marks]

(b) List three (3) common SAR Image Formation Algorithms.

[3 marks]

(c) Based on Geometry of Interferometry SAR shows in Figure Q2, show that the height of the terrain Z(x) can be written as,

$$z(x) = h - R\cos\left[\alpha - \sin^{-1}\left(\frac{\lambda\phi}{a\,2\pi B}\right)\right]$$

where a represent the different mode of interferometry SAR.

[17 marks]

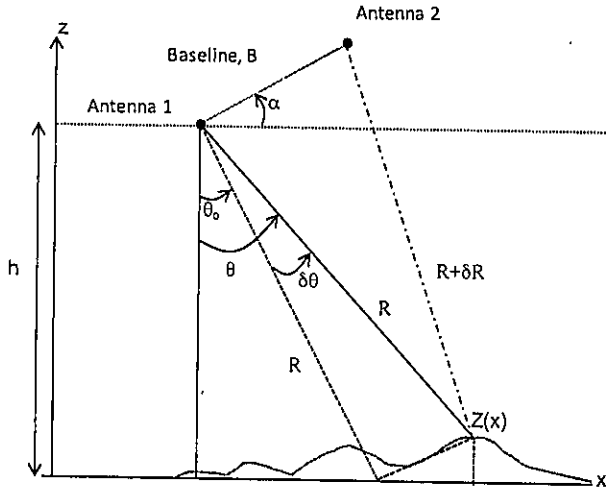

Figure Q2: Geometry of Interferometry SAR

Continued .....

Question 3

(a) A real aperture RADAR instrument at an altitude of 500m is being used to provide image data over fields and urban areas. The instrument has an aperture of 1.5m, operates at a wavelength of 0.01m and has a pulse length of 0.04×10^{-6}m. The mission requires identifying objects at a horizontal distance of 2km from the flight track that are more than 10m size in the across track (range) direction, separated by more than 10m in the along track (azimuth) direction.

(i) Can the instrument resolve these objects?

[10 marks]

(ii) If a Synthetic Aperture Radar is used instead of real aperture radar, propose the bandwidth of radar system as well as the antenna length to fulfil the across track (range) direction and the along track (azimuth) direction resolution of 10 m x 10 m.

[6 marks]

(iii) What is the corresponding sampling rate for this SAR signal at (ii)?

[2 marks]

(b) The noise figure and gain of a mixer/IF amplifier in a receiver is F2 = 4.5 dB and G2 = 25 dB, respectively (as shown in Fig. Q3). The noise figure and gain of a LNA in a receiver is F1 = 1.5 dB and G1 = 15 dB, respectively.

(i) Calculate the overall noise figure of this combination.

[3 marks]

(ii) Comment on the overall noise figure to noise figure of LNA alone and highlight the importance of LNA in typical radar receiver.

[4 marks]

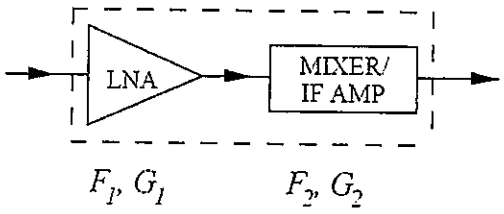

Fig. Q3

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(c) A synthetic aperture radar instrument has a range resolution of 10 m in the slant range direction and an azimuth resolution of 15 m. Suppose that the pixel spacing is exactly equal to the resolution. Data are processed on the satellite and sent to Earth with one byte representing each pixel.

(i) What is the ground range resolution of this instrument if it is operated with an incidence angle of 30°? What is the ground range resolution if the incidence angle increase to 60° ?

[3+2 marks]

(ii) At what incidence angle should the radar use to obtain "square"pixels on the ground?

[5 marks]

End of Paper